REVERSE OPTICAL TRANSITIONAL PROCESSES ON CRYSTAL SURFACES

I.V. GADOMSKAYA [a], O.N. GADOMSKY [a], V.V. SAMARTSEV [b]
[a] *Elabuga State Pedagogical Institute, 423630 Elabuga, USSR*
[b] *Kazan Physical Technical Institute Academy of Sciences, 420029 Kazan, USSR*

Received 4 July 1984

The possibility of the coherent nonlinear optical process excitation on the surface of crystals with the help of resonant pulse fields is analysed. The reverse photon echo phenomenon is considered.

The reverse photon (light) echo [1] is characterised in optical spectroscopy by an essentially increased signal-to-noise ratio as compared with the usual photon echo excited by travelling wave pulses [2]. Up to now, however, the reverse technique was used only to investigate relaxation processes inside volume crystals. Interesting perspectives are opened if this advantageous technique is used to study analogous processes on crystal surfaces. This paper is devoted to the possibility and the conditions of reverse optical transitional process formation on crystal surfaces.

The technique of surface wave coherent pulse excitation is well known [3,4]. In optics, for instance, it is realized by way of using reflecting prisms.

The scheme of the experiment offered here is shown in fig. 1. By means of a reflecting prism the coherent larger pulse spreads on the resonant medium surface (which may be ruby, the optical axis of which is parallel to the crystal surface and the spread direction) in the wave vector K direction. Obviously the exciting pulse duration must be shorter than the resonant irreversible relaxation times of the medium. If in some time interval, also shorter than the irreversible relaxation times, any part of the surface wave pulse spreading trajectory perpendicular to the direction K_1 is influenced by another laser pulse, this surface part of the medium will invariably irradiate the surface reverse photon echo (RRE) signal in the K direction, opposite to the first pulse wave vector duration. Let us consider the reasons of its appearance. It is sufficient to mention that the medium volume primary photon echo intensity is proportional to

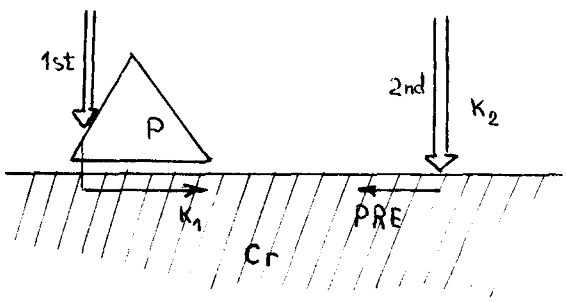

Fig. 1. Scheme for the reverse photon echo excitation on the crystal surface. P, the reflecting prism. 1st, 2nd, first and second exciting pulses. k_1, k_2, wave vectors of 1st and 2nd exciting pulses. RPE, the reverse photon echo signal. Cr, the crystal.

$$I \sim N^2 \int |\exp[\mathrm{i}(k - 2k_2 + k_1)r]_{\mathrm{av}}|^2 \,\mathrm{d}\Omega = \int \prod_{i=x,y,z} \frac{\sin^2(\frac{1}{2}a_i N_i)(k - 2k_2 + k_1)_i}{\sin^2(\frac{1}{2}a_i)(k - 2k_2 + k_1)_i} \times \sin\theta \,\mathrm{d}\theta \,\mathrm{d}\varphi\,, \quad (1)$$

where N is the total number of atoms, k is the echo signal wave vector, k_1 and k_2 are the first and second exciting pulses wave vectors.

The integration is performed over the angles θ and φ. The factor appeared as the light wavelength in optics and is much smaller than that of the sample. In accordance with ref. [2] the photon echo intensity in the